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(54) **ROLLOVER PREVENTION APPARATUS**

(71) Applicant: **Michael R. Schramm**, Perry, UT (US)

(72) Inventor: **Michael R. Schramm**, Perry, UT (US)

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Related U.S. Application Data

(63) Continuation of application No. 16/384,506, filed on Apr. 15, 2019, now Pat. No. 11,077,877, which is a continuation of application No. 15/442,573, filed on Feb. 24, 2017, now Pat. No. 10,259,494, which is a continuation of application No. 14/733,042, filed on Jun. 8, 2015, now Pat. No. 9,580,103, which is a continuation of application No. 14/145,950, filed on Jan. 1, 2014, now Pat. No. 9,050,997, which is a continuation-in-part of application No. 13/222,157, filed on Aug. 31, 2011, now Pat. No. 8,634,989.

(60) Provisional application No. 61/378,482, filed on Aug. 31, 2010, provisional application No. 61/385,535, filed on Sep. 22, 2010.

(51) **Int. Cl.**
B62D 5/00 (2006.01)
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(52) **U.S. Cl.**
CPC ***B62D 6/002*** (2013.01); ***B62D 1/16*** (2013.01); ***B62D 5/005*** (2013.01); ***B62D 6/008*** (2013.01); ***B62D 15/025*** (2013.01); ***B62D 15/0215*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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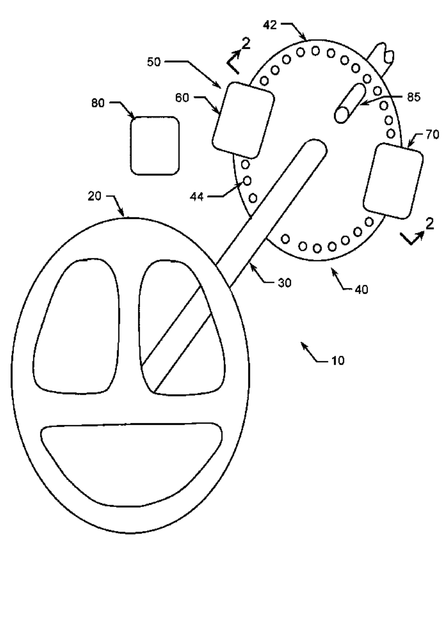
Primary Examiner — McDieunel Marc
(74) *Attorney, Agent, or Firm* — Michael R. Schramm

(57) **ABSTRACT**

The rollover prevention apparatus defines an adaptive steering range limiting device comprising a control unit and a pair of opposing unidirectional brake assemblies mounted to a steering column position detection disc. The rollover prevention apparatus prevents the steering wheel of the vehicle from being turned beyond the threshold of vehicle rollover, but otherwise does not restrict the rotational range of motion of the steering wheel of a vehicle.

20 Claims, 10 Drawing Sheets



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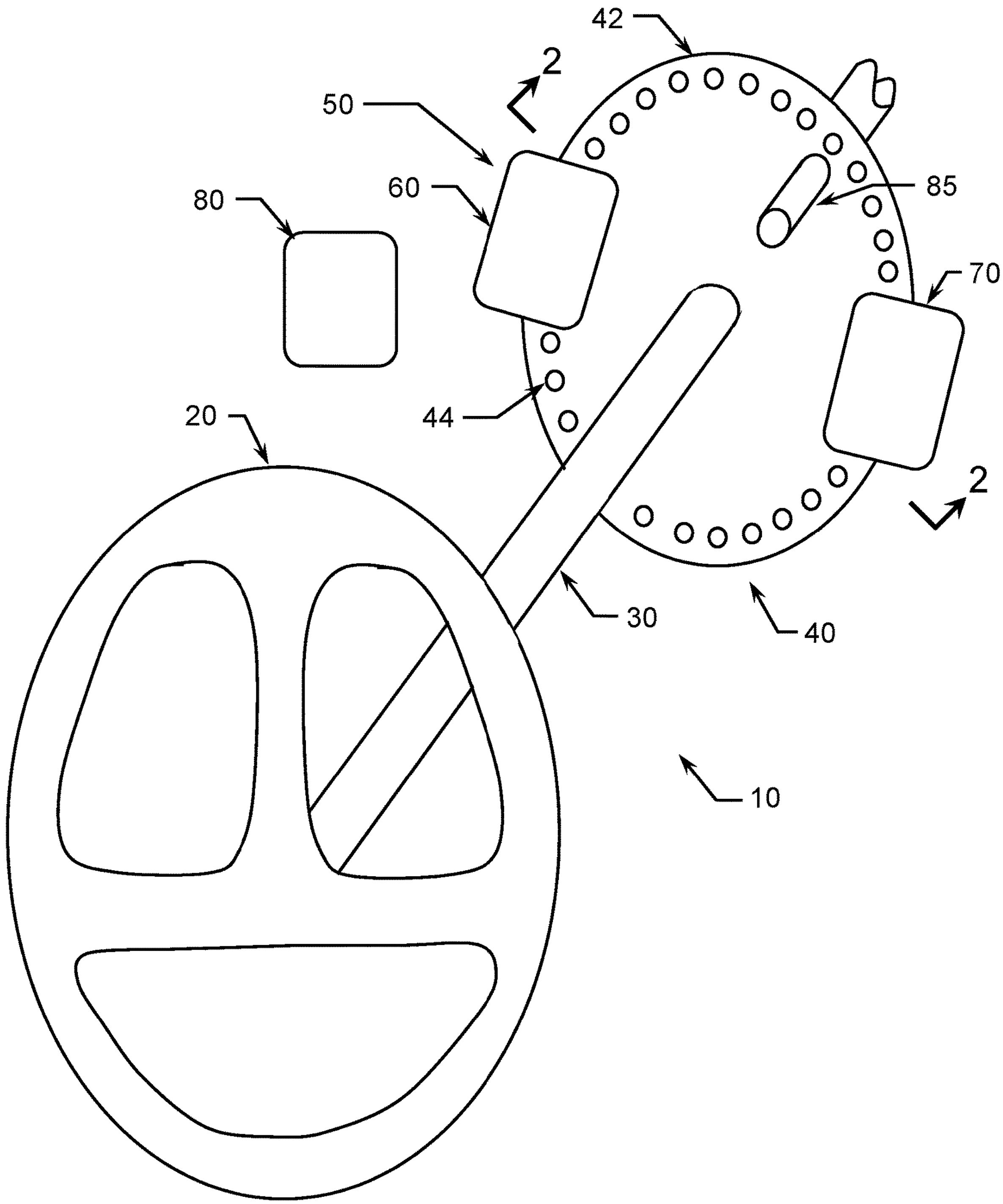
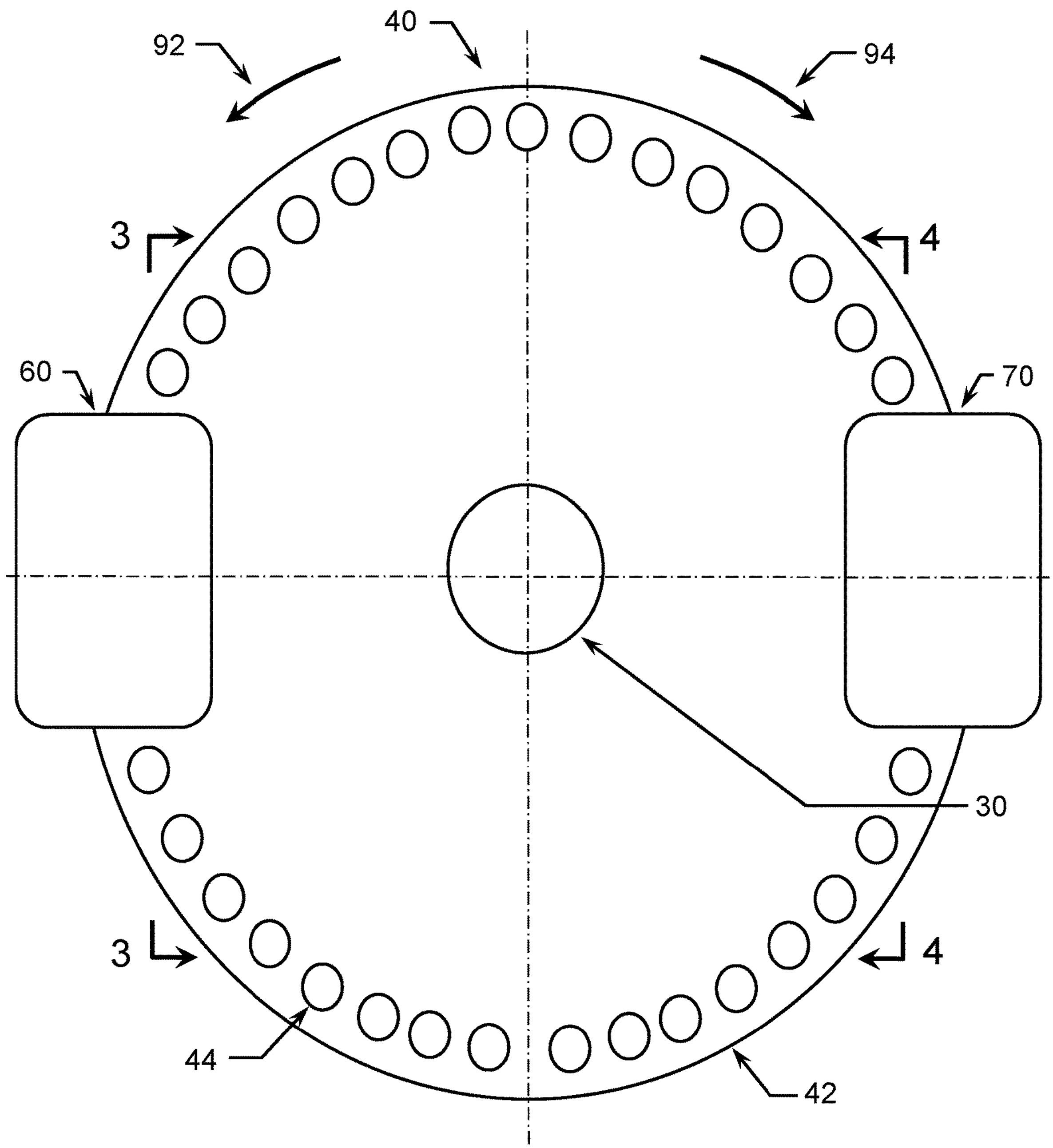


Figure 1



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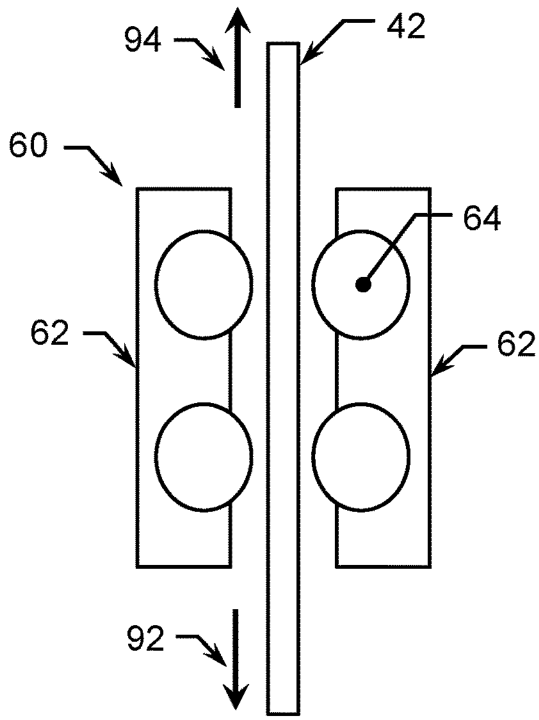
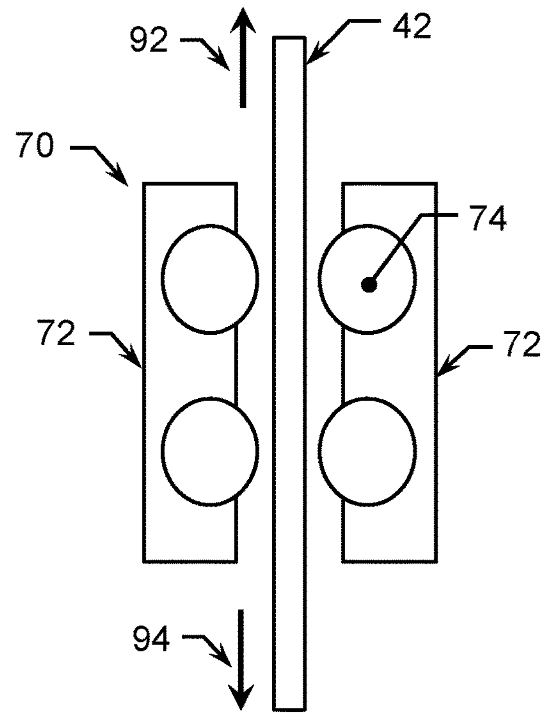


Figure 3A



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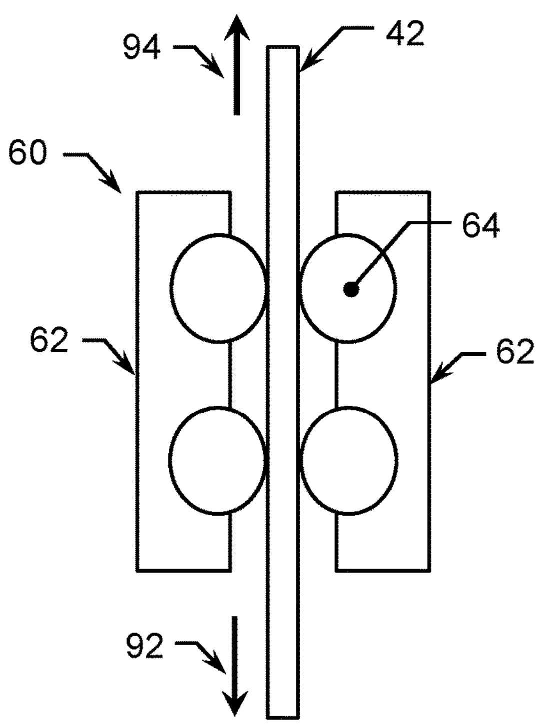


Figure 3B

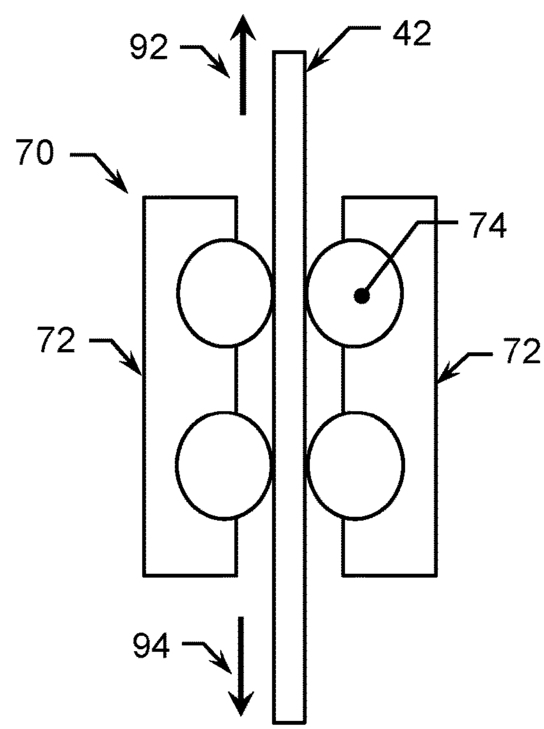
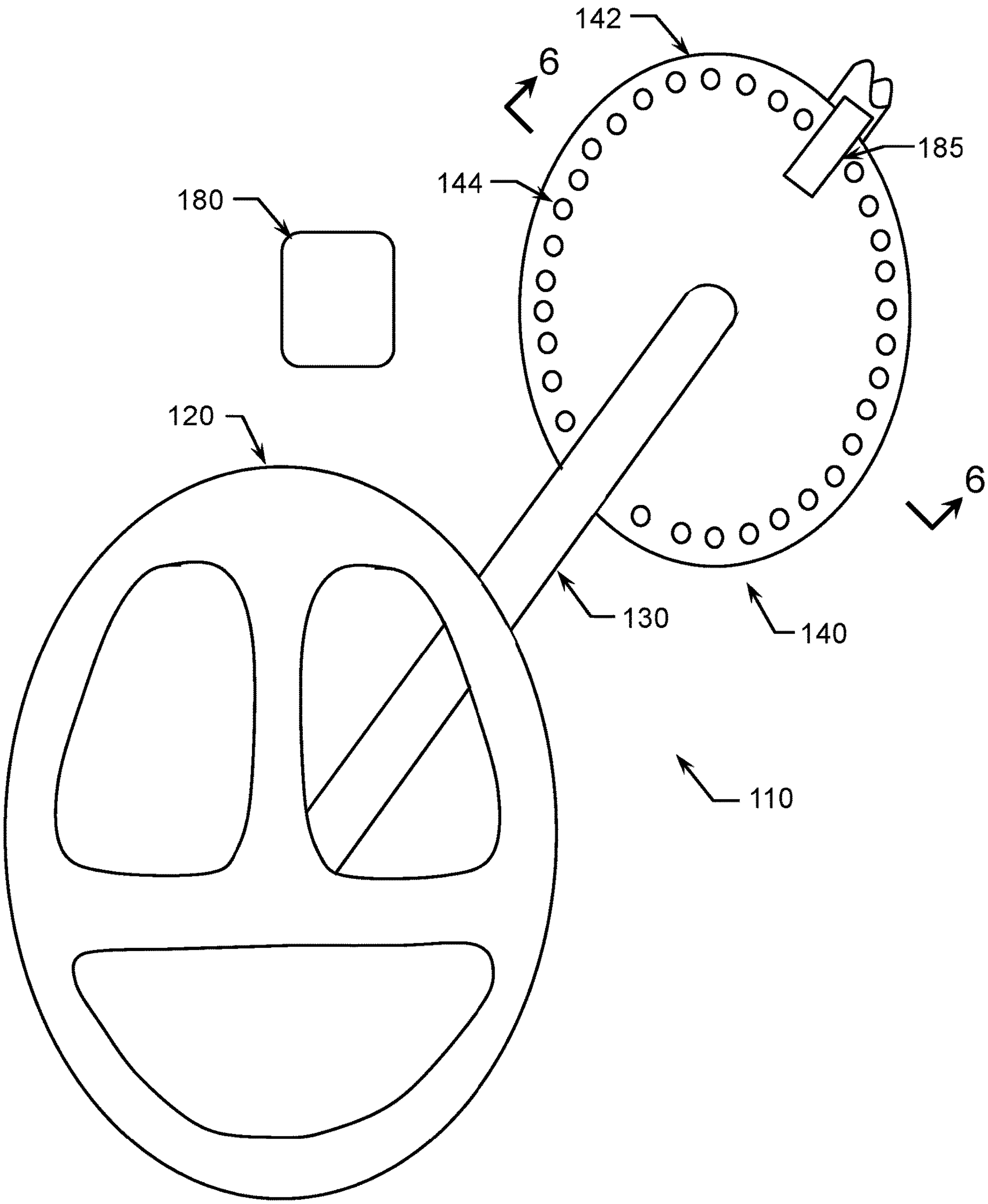


Figure 4B



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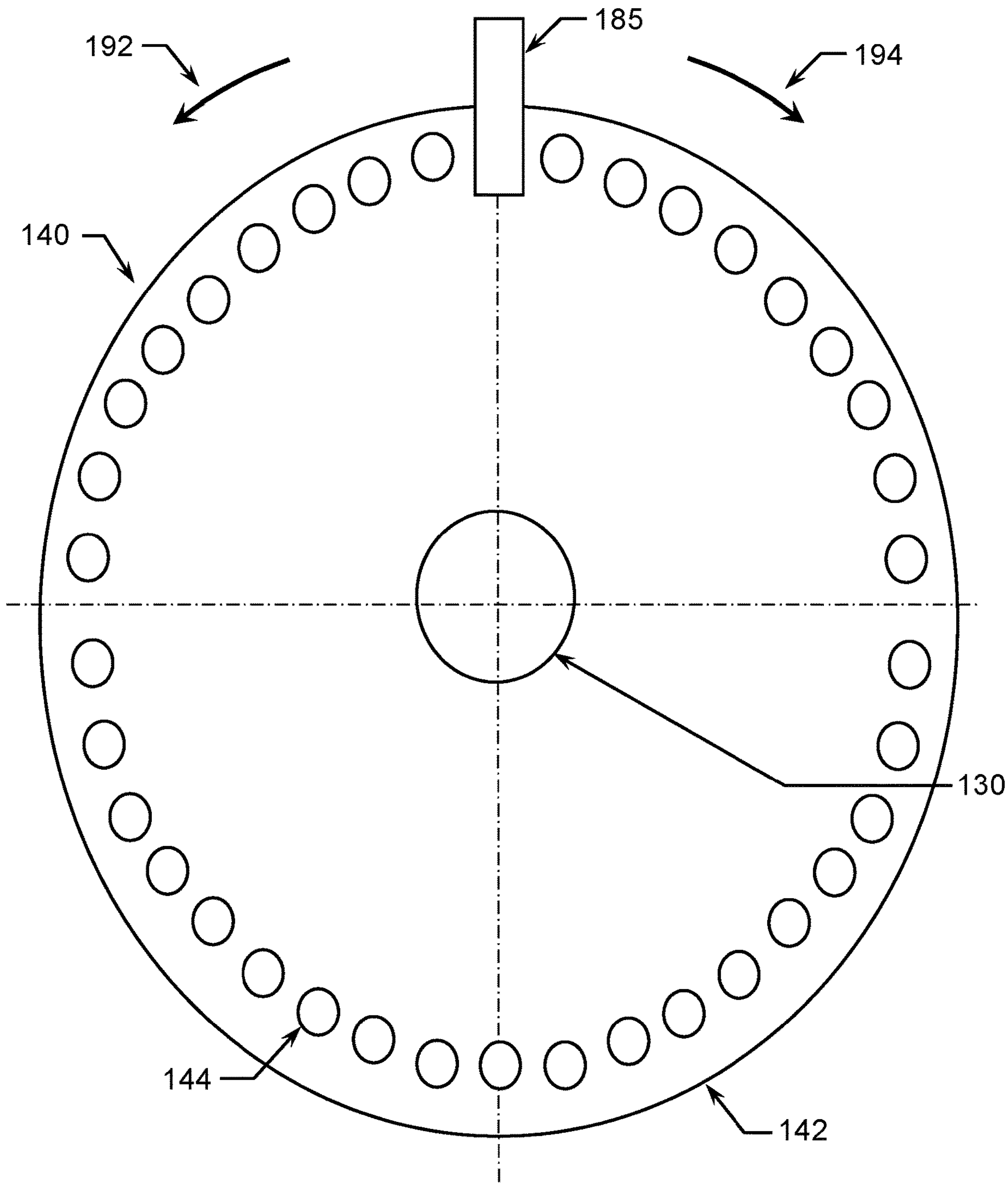


Figure 6A

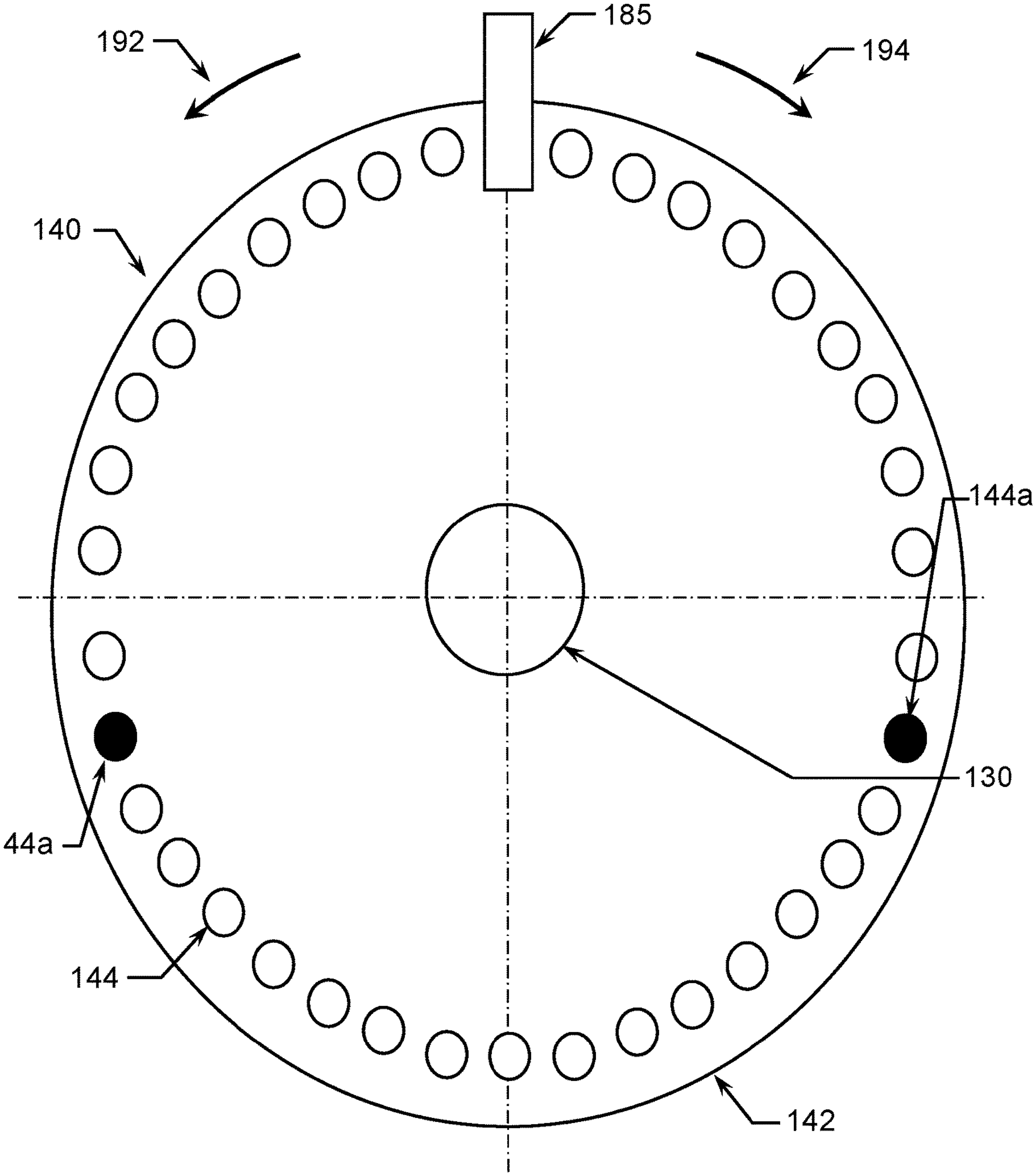
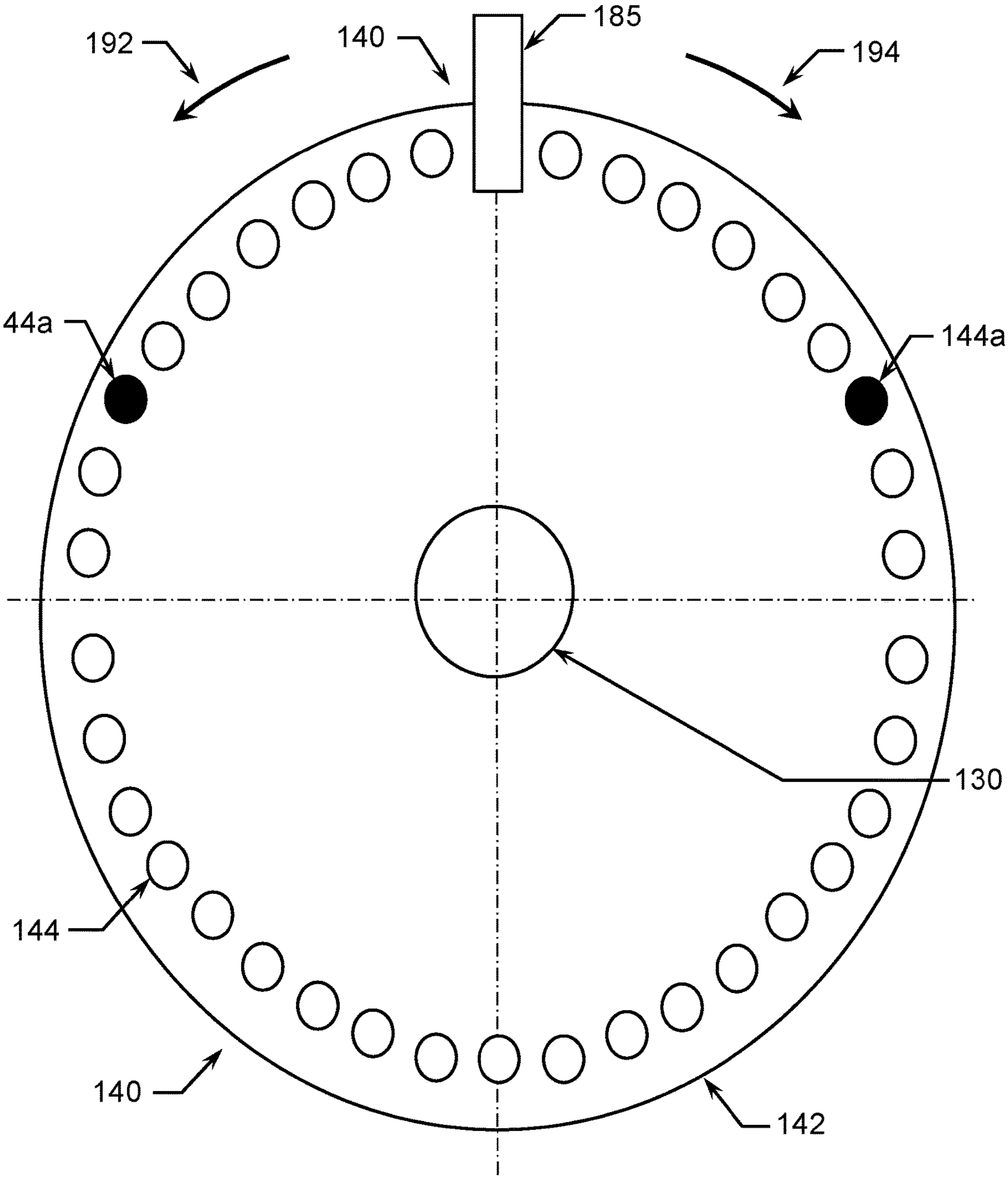


Figure 6B



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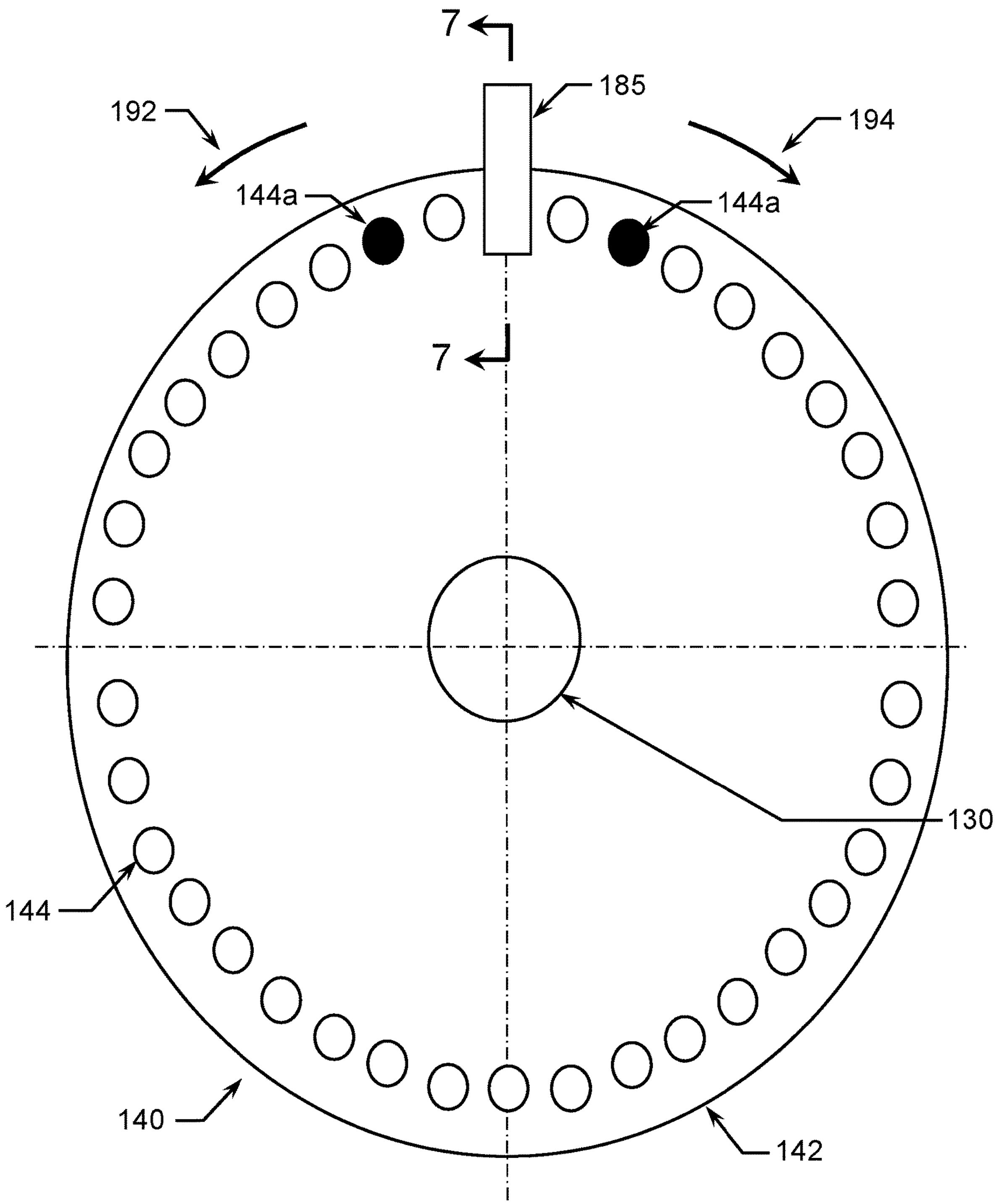

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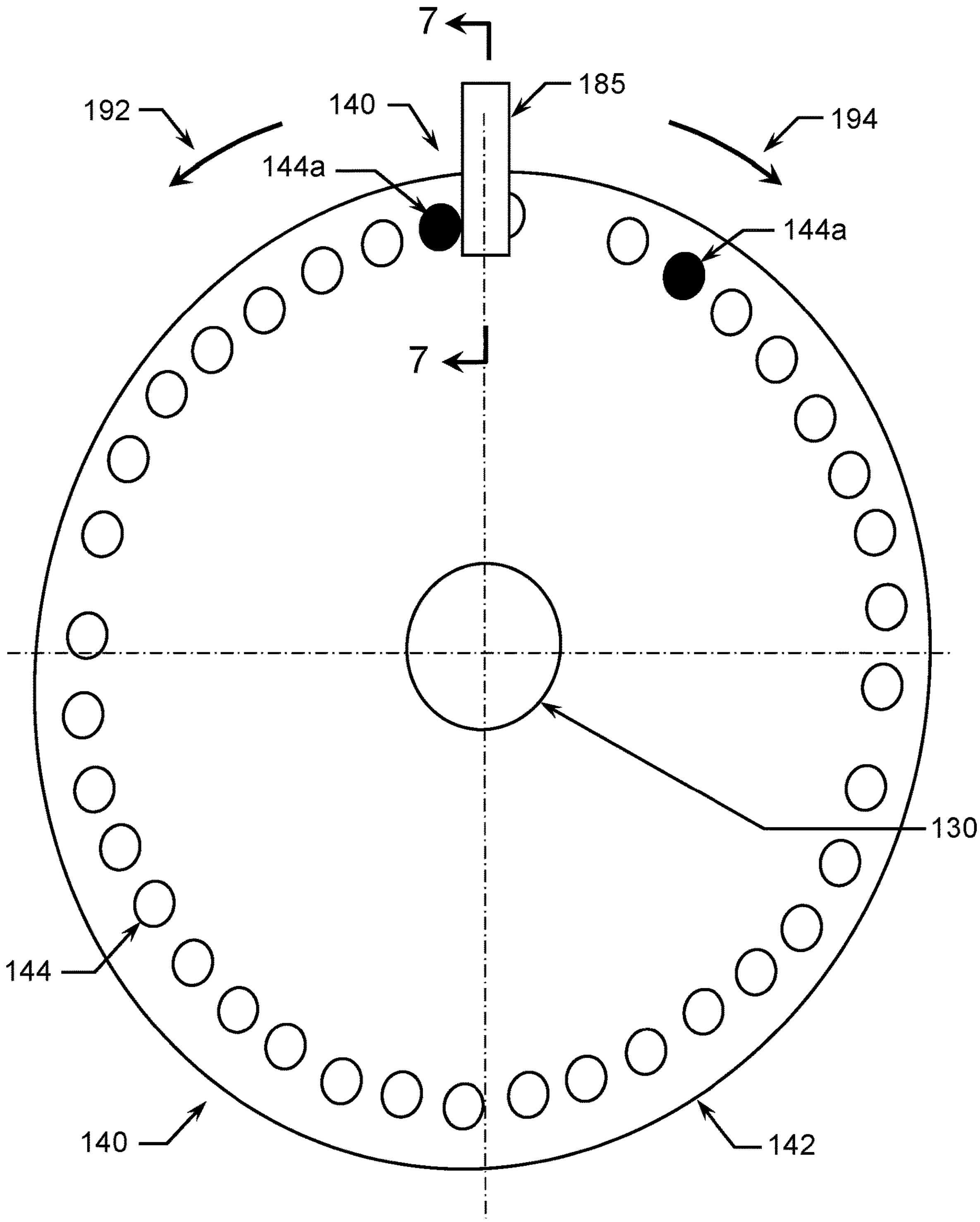

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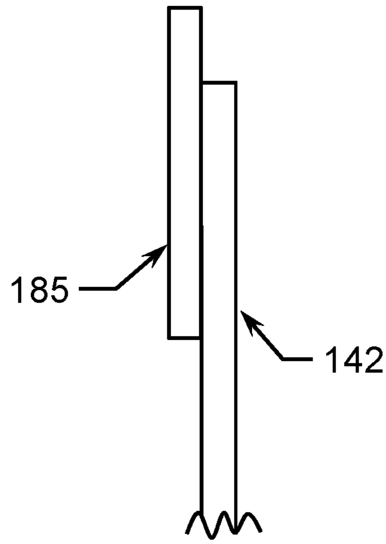

Figure 7

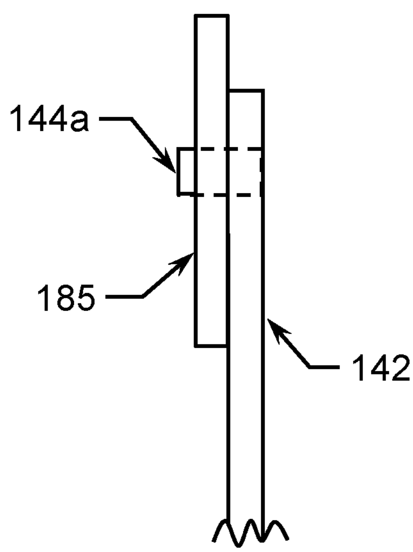

Figure 7A

ROLLOVER PREVENTION APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

This nonprovisional utility patent application is a continuation of and claims the benefit under 35 USC § 120 to U.S. application Ser. No. 16/384,506 filed Apr. 15, 2019 and expected to issue as U.S. Pat. No. 11,077,877 on Aug. 3, 2021, which is a continuation of and claims the benefit under 35 USC § 120 to U.S. application Ser. No. 15/442,573 filed Feb. 24, 2017 and since issued as U.S. Pat. No. 10,259,494 on Apr. 16, 2019, which is a continuation of and claims the benefit under 35 USC § 120 to U.S. application Ser. No. 14/733,042 filed Jun. 8, 2015 and since issued as U.S. Pat. No. 9,580,103 on Feb. 28, 2017, which is a continuation of and claims the benefit under 35 USC § 120 to U.S. application Ser. No. 14/145,950 filed Jan. 1, 2014 and since issued as U.S. Pat. No. 9,050,997 on Jun. 9, 2015, which is a continuation-in-part of and claims the benefit under 35 USC § 120 to co-pending U.S. application Ser. No. 13/222,157 filed Aug. 31, 2011 and since issued as U.S. Pat. No. 8,634,989 on Jan. 21, 2014, which claims the benefit under 35 USC § 119(e) of U.S. provisional application No. 61/378,482 filed Aug. 31, 2010 and of U.S. provisional application No. 61/385,535 filed Sep. 22, 2010, all of which are expressly incorporated herein in their entirety by this reference.

FIELD OF THE INVENTION

The present invention relates to steering control devices and more especially devices for use in preventing steering to the point of vehicle rollover.

BACKGROUND OF THE INVENTION

Vehicle rollover—generally defined as vehicular accident in which a vehicle turns over on its side or roof—is an extremely dangerous form of a vehicle crash. Vehicle rollover accidents while relatively rare—estimated at approximately 3% of all vehicle crashes—account for a disproportionately high number of fatal crashes—estimated at approximately 31% of all fatal vehicle crashes. The Nation Highway Transportation Safety Administration (NHTSA) reported that 10,666 people were killed in the US in vehicle rollover crashes in 2002. Many factors are involved in a vehicle rollover including for instance vehicle center of gravity, vehicle suspension stiffness, vehicle tire traction, etc. However, according to Wikipedia, "The main cause for rolling over is turning too sharply while moving too fast" (see Appendix A, page 1, first paragraph). While there may be several factors for a vehicle to be turned or steered beyond the vehicle threshold of roll such as driver hurry or impatience and driver inexperience, a well know cause for excessive turning or steering to the point of vehicle roll is the occurrence of an object such as a tumble weed or squirrel suddenly appearing in the drivers path (hereafter referred to Sudden Object Appearance or SOA). In such SOA, even the most experienced drivers can feel the inherent and immediate urge to rapidly turn the steering wheel. It is just such turning of the steering wheel that causes many vehicle rollovers.

In recent years, a system commonly referred to as Electronic Stability Control or ESC has, by automatically selectively apply torque or braking force to certain of a vehicles wheels, been used in significantly improving stability of vehicles, especially when such vehicles would have otherwise "spun out" or "fish-tailed" when cornering. However, such ESC systems, which typically require complex rollover prediction schemes, cannot prevent vehicle rollover when a vehicle steering wheel is turned too sharply for the vehicle speed as in a SOA situation. Further, a number of inventions dealing with vehicle steering control have been developed over the years. However, such inventions have typically merely dealt with preventing damage to a driving surface (i.e. turf) or prevention of a power steering system, and no such systems are known to prevent vehicle rollover, especially in a SOA situation. Examples of such inventions are provided in the following list of US patents and applications, the whole of which are incorporated herein by reference: U.S. Pat. Nos. 5,489,006, 6,584,388, 6,588,799, 6,714,848, 6,954,140, 7,107,136, 7,261,303, 7,325,644, 7,440,844, 7,613,555, 20030055549, 20030088349, 20030093201, 20040102894, 20040104066, 20040215384, 20050060069, 20050110227, 20060030991, 20060129298, 20060162987, 20070299583, 20080133101, 20090228173, 20100191423, and 20110060505.

SUMMARY OF THE INVENTION

The present invention is a vehicle rollover prevention apparatus. Thus unless indicated otherwise, where used in this application, the term "Anti-Roll Steering" or "ARS" shall be understood to mean a system or apparatus that adaptively adjusts the steering range of motion of a vehicle such as to prevent rollover of the vehicle. Thus for instance, ARS allows a vehicle steering to be steered in a full unrestricted range of motion when the vehicle is moving substantially below a predetermined speed (such as the speed that correlates to a roll threshold of the vehicle at a given turn angle or turn rate of the vehicle), but prevents a vehicle steering from being steered in a full unrestricted range of motion when the vehicle is moving at or near the predetermined speed. In a first embodiment, the apparatus defines an adaptive steering range limiting device (ASRLD) comprising a control unit and a pair of opposing unidirectional brake assemblies mounted to a steering column position detection disc (SCPDD). The unidirectional brake assemblies comprise a first left hand unidirectional brake assembly (LHUBA) and a second right hand unidirectional brake assembly (RHUBA), with the LHUBA operable to brake in a left hand or counterclockwise (CCW) direction and yet roll substantially freely in a right hand or clockwise (CW) direction, and with the RHUBA operable to brake in a right hand or clockwise (CW) direction and yet roll substantially freely in a left hand or counterclockwise (CCW) direction. The SCPDD includes at least one and preferably a plurality of sensors that sense the angular position of a vehicle steering wheel and provide such angular position information to the control unit. The control unit also receives speed data from a vehicle speed sensor. In practice, when a vehicle in which the ASRLD is installed is moving at less than a predetermined rate of speed, the unidirectional brake assemblies are not applied, and the vehicle steering wheel may be turned to the full hand range of steering motion. However, when a vehicle in which the ASRLD is installed is moving at no less than a predetermined rate of speed and the vehicle steering wheel is turned to no less than a predetermined left hand angle, the LHUBA is automatically applied, and the vehicle steering left hand range of motion is restricted such that the steering wheel may not be turned beyond the threshold of left hand rollover for the particular vehicle for the given vehicle speed. When the vehicle speed and/or steering wheel left hand angle is reduced, the LHUBA is automatically released. Further, when a vehicle in which the ASRLD is installed is moving at no less than a predetermined rate of speed and the vehicle steering wheel is turned to no less than a predetermined right hand angle, the RHUBA is automatically applied, and the vehicle steering right hand range of motion is restricted such that the steering wheel may not be turned beyond the threshold of right hand rollover for the particular vehicle for the given vehicle speed. When the vehicle speed and/or steering wheel right hand angle is reduced, the RHUBA is automatically released. It is noted that when the unidirectional brake assemblies are (separately) applied, although the steering wheel is prevented from being turn beyond a predetermined left hand or right hand angle, the steering wheel is free to be turned back toward a steering wheel centered or neutral position. In this method, a vehicle is prevented from being steered beyond the threshold of vehicle role and yet the vehicle steering wheel remains otherwise usable over the unrestrained rotational range of travel.

DESCRIPTION OF DRAWINGS

In order that the advantages of the invention will be readily understood, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments that are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings, in which:

FIG. **1** is a trimetric view of a first embodiment of the invention;

FIG. **2** is an orthographic cross-sectional view of the first embodiment of the invention taken substantially at the location indicated by the cross-section arrows annotated with “2” in FIG. **1**;

FIG. **3**A is an orthographic cross-sectional view of the first embodiment of the invention taken substantially at the location indicated by the cross-section arrows annotated with “3” in FIG. **2**, the invention is shown with the LHUBA in an unactuated or open position;

FIG. **3**B is an orthographic cross-sectional view of the first embodiment of the invention taken substantially at the location indicated by the cross-section arrows annotated with “3” in FIG. **2**, the invention is shown with the LHUBA in an actuated or closed position;

FIG. **4**A is an orthographic cross-sectional view of the first embodiment of the invention taken substantially at the location indicated by the cross-section arrows annotated with “4” in FIG. **2**, the invention is shown with the RHUBA in an unactuated or open position;

FIG. **4**B is an orthographic cross-sectional view of the first embodiment of the invention taken substantially at the location indicated by the cross-section arrows annotated with “4” in FIG. **2**, the invention is shown with the RHUBA in an actuated or closed position;

FIG. **5** is a trimetric view of a fourth embodiment of the invention;

FIG. **6**A is an orthographic cross-sectional view of the fourth embodiment of the invention taken substantially at the location indicated by the cross-section arrows annotated with “6” in FIG. **5**;

FIG. **6**B is substantially similar to FIG. **6**A except that a first set of actuator pins are shown as extended;

FIG. **6**C is substantially similar to FIG. **6**A except that a second set of actuator pins are shown as extended;

FIG. **6**D is substantially similar to FIG. **6**A except that a third set of actuator pins are shown as extended;

FIG. **6**E is substantially similar to FIG. **6**D except that SCDD **140** is shown rotated to the limit of its right hand rotational range of motion;

FIG. **7** is an orthographic cross-sectional view of the fourth embodiment of the invention taken substantially at the location indicated by the cross-section arrows annotated with “7” in FIG. **6**D, with the invention shown without an actuation pin **144** blocking rotational motion of SCDD **140**, and;

FIG. **7**A is an orthographic cross-sectional view of the fourth embodiment of the invention taken substantially at the location indicated by the cross-section arrows annotated with “7” in FIG. **6**E, with the invention shown with an actuation pin **144***a* blocking rotational motion of SCDD **140**.

DETAILED DESCRIPTION OF THE INVENTION

Reference throughout this specification to “one embodiment,” “an embodiment,” or similar language means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases “in one embodiment,” “in an embodiment,” and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment.

Furthermore, the described features, structures, or characteristics of the invention may be combined in any suitable manner in one or more embodiments. In the following description, numerous specific details are included to provide a thorough understanding of embodiments of the invention. One skilled in the relevant art will recognize, however, that the invention can be practiced without one or more of the specific details, or with other methods, components, materials, and so forth. In other instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring aspects of the invention.

In order to facilitate the understanding of the present invention in reviewing the drawings accompanying the specification, a feature table is provided below. It is noted that like features are like numbered throughout all of the figures.

FEATURE TABLE

#	Feature
10	adaptive steering range limiting device
20	steering wheel
30	steering column
40	steering column position detection disc
42	disc
44	magnetic target
50	unidirectional brake assemblies
60	left hand unidirectional brake assembly
62	caliper housing
64	unidirectional roller
70	right hand unidirectional brake assembly
72	caliper housing
74	unidirectional roller
80	electronic control unit

-continued

FEATURE TABLE

#	Feature
85	sensor
92	left hand or CCW direction indication arrow
94	right hand or CW direction indication arrow
110	adaptive steering range limiting device
120	steering wheel
130	steering column
140	steering column disc device
142	disc
144	actuator pin
144a	actuator pin-extended
180	electronic control unit
185	block
192	left hand or CCW direction indication arrow
194	right hand or CW direction indication arrow

Referring now to FIGS. **1** through **4** of the drawings, a first embodiment of the invention is an adaptive steering range limiting device (ASRLD) **10** comprising a steering wheel **20**, a steering column **30**, a steering column position detection disc (SCPDD) **40**, a pair of opposing unidirectional brake assemblies **50**, an electronic control unit **80** and a sensor **85**. Furthermore arrow **92** defines a left hand or counterclockwise (CCW) direction indication arrow and arrow **94** defines a right hand or clockwise (CW) direction indication arrow. Steering wheel **20** defines a conventional steering wheel as may commonly be found in a commercially available passenger vehicle. Steering column **30** defines a conventional steering column that serves to transmit steering torque from steering wheel **20** to a rack and pinion or other such vehicle wheel control device. SCPDD **40** defines a substantially thin preferably aluminum cylinder shaped disc **42** having a plurality of magnetic targets **44** embedded within disc **42** and spaced substantially equally about the periphery of disc **42**. Unidirectional brake assemblies **50** define an assembly comprising a left hand unidirectional brake assembly (LHUBA) **60** and a right hand unidirectional brake assembly (RHUBA) **70**. LHUBA **60** defines a brake assembly having a caliper housing **62**, and a plurality of actuatable or extendable and retractable unidirectional rollers **64**. Unidirectional roller **64** preferably comprises a generally hard rubber roller mounted on at least one unidirectional bearing. Unidirectional bearings are well known in the art and are for instance taught in U.S. Pat. Nos. 3,805,932 and 5,547,055, which are incorporated herein by reference. RHUBA **70** defines a brake assembly having a caliper housing **72**, and a plurality of actuatable or extendable and retractable unidirectional rollers **74**. Unidirectional roller **74** preferably comprises a generally hard rubber roller mounted on at least one unidirectional bearing. Electronic control unit **80** defines an electronic control unit such as are commonly in use in automobiles, and is adapted to electronically receive speed, position and other sensor input and is adapted to electronically transmit actuation signals based on predetermined inputs. Sensor **85** preferably defines an electronic sensor such as reed switch type sensor that is operable to detect near proximity to magnetic targets **44**, and thus is operable to detect rotational positioning of SCPDD **40**.

ASRLD **10** is assembled such that steering column **30** is connected to steering wheel **20** on a first end of steering column **30** and to SCPDD **40** on a second end of steering column **30**. Unidirectional brake assemblies **50** are positioned near SCPDD **40** such that disc **42** may rotatingly pass between rollers **64** and between rollers **74**. Electronic control

unit **80** is electronically connected to unidirectional brake assemblies **50** and electronically connected to sensor **85**. ASRLD **10** is mounted in a vehicle such that second end of steering column **30** is steeringly connected to a rack and pinion or like steering mechanism of the vehicle such that ASRLD **10** is operable to steer the vehicle. Unidirectional brake assemblies **50** are further connected to a structural member of the vehicle such that unidirectional brake assemblies **50** remain stationary relative to a rotation movement of SCPDD **40** and such that unidirectional brake assemblies **50** are able to react or withstand a steering stopping load. Electronic control unit **80** is further connected to a structural member of the vehicle such that electronic control unit **80** remains stationary regardless of rotation movement of SCPDD **40**. Sensor **85** is further connected to a structural member of the vehicle such that sensor **85** remains stationary relative to a rotation movement of SCPDD **40** and such that sensor **85** is able to detect magnetic targets **44** as magnetic targets **44** move into a near proximity position to sensor **85**.

In practice, with ASRLD **10** operably mounted in a vehicle, when the vehicle is moving below a predetermined speed, for instance less than 10 miles per hour (mph), unidirectional brake assemblies **50** are not actuated as shown in FIGS. **3**A and **4**A, and steering wheel **20** may be freely rotated through its the full rotational range of motion. It is noted that when steering wheel **20** is rotated, SCPDD **40** correspondingly rotates between rollers **64** and between rollers **74** and sensor **85** and electronic control unit **80** monitors the rotational orientation of SCPDD **40**. However, when the vehicle is moving at or above a predetermined speed, for instance 10 miles per hour (mph), and SCPDD **40** is sensed at being at or above a left hand rotational orientation of greater than a predetermined amount, for instance 10 degrees CCW from a center or neutral steering position, electronic control unit **80** determines a steering prevention threshold has been achieved and sends an actuation signal to LHUBA **60**, and LHUBA **60** actuates by moving unidirectional rollers **64** into unidirectional braking contact with SCPDD **40** as shown in FIG. **3**B and steering wheel **20** is prevented from rotating further in a left hand or CCW direction but is free to rotate in a right hand or CW direction. When the vehicle slows to less than the predetermined speed or when steering wheel **20** is rotated to a rotational orientation of below the predetermined amount, LHUBA **60** "deactuates" by moving unidirectional rollers **64** out of braking contact with SCPDD **40** as shown in FIG. **3**A, and steering wheel **20** may again be rotated freely in both directions (CCW and CW) unless and until another steering prevention threshold is reached. Further, when the vehicle is moving at or above a predetermined speed, for instance 10 miles per hour (mph), and SCPDD **40** is sensed at being at or above a right hand rotational orientation of greater than a predetermined amount, for instance 10 degrees CW from a center or neutral steering position, electronic control unit **80** determines a steering prevention threshold has been achieved and sends an actuation signal to RHUBA **70**, and RHUBA **70** actuates by moving unidirectional rollers **74** into unidirectional braking contact with SCPDD **40** as shown in FIG. **4**B and steering wheel **20** is prevented from rotating further in a right hand or CW direction but is free to rotate in a left hand or CCW direction. When the vehicle slows to less than the predetermined speed or when steering wheel **20** is rotated to a rotational orientation of below the predetermined amount, RHUBA **70** "deactuates" by moving unidirectional rollers **74** out of braking contact with SCPDD **40** as shown in FIG. **4**A, and steering wheel **20** may again be rotated freely in both directions (CCW and CW) unless and until another steering prevention threshold is reached.

It is noted that ASRLD **10** is preferably adapted such that the various steering prevention thresholds are of substantially fine increments such that the braking of steering wheel **20** is accomplished in a fashion that approximates a smooth non-stair-stepped method. For example, if a vehicle equipped with ASRLD **10** were to be traveling on a substantially large flat horizontal paved surface at a high rate of speed, such as for instance 100 mph, and steering wheel **20** were to be turned hard to the right (or the left), ASRLD **10** would prevent steering wheel **20** from being turned to the right (or the left) to the point that the vehicle would rollover to the left (or to the right), and would more specifically, allow steering wheel **20** to be turned to the right (or the left) very near to but just less than the threshold of vehicle rollover. Further, in the above described scenario, if the right hand (or left hand) steering load were maintained on steering wheel **20** and the vehicle was to be allowed to decelerate, such as by coasting or by braking, the vehicle would turn to the right (or to the left) at an substantially continuously sharper right hand (or left hand) turn (e.g. a substantially decreasing turn radius) corresponding to the decreased rate of speed until the vehicle slowed to the point that it would be traveling at less than the first or slowest steering prevention threshold (such as less than 10 mph). Once the vehicle slowed to the first or slowest steering prevention threshold, the vehicle would then turn to the right (or to the left) at a constant turn rate which would be the full unrestricted turn rate of the vehicle. Thus by this description, it can be seen that at substantially any speed of the vehicle, the vehicle is allowed to turn at a rate approaching but just less than the vehicle rollover threshold for such given "any" speed. ASRLD **10** is somewhat analogous to "anti-lock braking". With anti-lock braking, braking and vehicle control is maximized (breaking distance minimized) by allowing the brakes to apply a braking force that approaches but is never allowed to exceed the tire-to-ground traction breaking threshold. Analogously, with ASRLD **10**, steering and vehicle control is maximized by allowing the vehicle to be steered to a degree that approaches but is never allowed to exceed the vehicle rollover threshold.

It is noted that each vehicle model or alteration thereof may have a different propensity for roll. In the first embodiment, such propensity is predetermined and corresponding combinations of turn degree and vehicle speed are determined for various vehicle rollover thresholds. However, it is also understood that vehicle roll propensity is influenced a plurality of factors. In addition to speed and turn degree, such factors may include for instance vehicle center of gravity, vehicle suspension stiffness, vehicle wheel base width, vehicle loading, vehicle tire pressure, traction between a road and the vehicle tires, road angle/banking, etc. Thus in a second embodiment, the second embodiment is substantially identical to the first embodiment except that in the second embodiment, factors in addition to vehicle speed and turn degree are monitored and rollover thresholds are determined on-the-fly. Further in the second embodiment, in order to prevent vehicle rollover due to continued or increased acceleration post-actuation of ASRLD **10**, electronic control unit **80** is adapted such that whenever ASRLD **10** is actuated, electronic control unit **80** sends a signal to an accelerator control device such that a vehicle is prevented from further acceleration during the duration of ASRLD **10** actuation.

It is noted that inasmuch as there may be a belief by some that certain circumstances may exist wherein the likelihood of injury or death may be less if a vehicle is allowed to be steered beyond a vehicle threshold of rollover than if a vehicle is restricted from being steered beyond a vehicle threshold of rollover. To satisfy such potential concerns, in a third embodiment, the third embodiment is substantially identical to the second embodiment except that the third embodiment includes an override mode. In such override mode the steering rotational range of motion is automatically not restricted even if a steering prevention threshold is exceeded if an override logic criterion is satisfied. Such override logic criteria may comprise for instance, the detection of a human in near proximity of the drive path of the vehicle or for instance, the detection of a road surface having less than a predetermined coefficient of friction (e.g. an ice packed road).

Referring now to FIGS. **5** through **7** of the drawings, a fourth embodiment of the invention is an adaptive steering range limiting device (ASRLD) **110** comprising a steering wheel **120**, a steering column **130**, a steering column disc device (SCDD) **140**, an electronic control unit **180** and a block **185**. Furthermore arrow **192** defines a left hand or counterclockwise (CCW) direction indication arrow and arrow **194** defines a right hand or clockwise (CW) direction indication arrow. Steering wheel **120** defines a conventional steering wheel as may commonly be found in a commercially available passenger vehicle. Steering column **130** defines a conventional steering column that serves to transmit steering torque from steering wheel **120** to a rack and pinion or other such vehicle wheel control device. SCDD **140** defines a substantially thin preferably aluminum cylinder shaped disc **142** having a plurality of actuator pins **144** affixed to disc **142** and spaced substantially equally about the periphery of disc **142**. Actuator pins **144** are mounted to disc **142** such that in an un-actuated or retracted position, actuator pins **144** are positioned substantially flush with disc **142** and such that in an actuated or extended position, actuator pins **144** are positioned substantially in a position so as to potentially interfere with block **185**. Electronic control unit **80** defines an electronic control unit such as are commonly in use in automobiles, and is adapted to electronically receive speed input and is adapted to electronically transmit actuation signals based on predetermined inputs. Block **185** preferably defines rigidly fixed preferably metallic block that is connect to a vehicle structural member and does not move with disc **142**.

ASRLD **110** is assembled such that steering column **130** is connected to steering wheel **120** on a first end of steering column **130** and to SCDD **140** on a second end of steering column **130**. Electronic control unit **180** is electronically connected to actuator pins **144**. ASRLD **110** is mounted in a vehicle such that second end of steering column **130** is steeringly connected to a rack and pinion or like steering mechanism of the vehicle such that ASRLD **110** is operable to steer the vehicle. Block **185** is connected to a structural member of the vehicle such that block **185** remains stationary relative to a rotation movement of SCDD **140** and such that block **185** is able to react or withstand a steering stopping load. Electronic control unit **180** is further connected to a structural member of the vehicle such that electronic control unit **180** remains stationary regardless of rotation movement of SCDD **140**.

In practice, with ASRLD **110** operably mounted in a vehicle, when the vehicle is moving below a predetermined speed, for instance less than 5 miles per hour (mph), none of actuator pins **144** are actuated as shown in FIGS. **6**A and **6**, and steering wheel **120** may be freely rotated through its the full (unrestricted) rotational range of motion. It is noted that when steering wheel **120** is rotated, SCDD **140** correspondingly in very near proximity to stationary block **185**. However, when the vehicle is moving at or above a first predetermined speed, for instance 10 miles per hour (mph), electronic control unit **80** determines a first steering prevention threshold has been achieved and sends an actuation signal to a first set of actuator pins **144** as shown in FIG. **6**B and steering wheel **120** is prevented from rotating beyond a first restricted range of rotational motion. When the vehicle is moving at or above a second predetermined speed, for instance 35 miles per hour (mph), electronic control unit **80** determines a second steering prevention threshold has been achieved and sends an actuation signal to a second set of actuator pins **144** as shown in FIG. **6**C and steering wheel **120** is prevented from rotating beyond a second restricted range of rotational motion. When the vehicle is moving at or above a third predetermined speed, for instance 65 miles per hour (mph), electronic control unit **80** determines a third steering prevention threshold has been achieved and sends an actuation signal to a third set of actuator pins **144** as shown in FIG. **6**D and steering wheel **120** is prevented from rotating beyond a third restricted range of rotational motion. When the vehicle slows to less than a given predetermined speed threshold, or when a more restrictive set of actuator pins **144** are actuated or extended, electronic control unit **80** sends an retraction signal to a given set of actuator pins **144**, and actuator pins **144** "deactuate" or retract and return to their home position, steering wheel **120** may again be rotated freely in both directions (CCW and CW) unless and until another steering prevention threshold is reached. It is noted that in the fourth embodiment of the invention, in contrast to systems that react to initiation of vehicle rollover. ASRLD **110** functions in a "proactive" mode by preventing the vehicle from initiating a rollover.

It is noted that ASRLD **110** is preferably adapted such that the various steering prevention thresholds are of substantially fine increments such that the varying of steering range of motion of steering wheel **120** is accomplished in a fashion that approximates a smooth non-stair-stepped method. For example, if a vehicle equipped with ASRLD **110** were to be traveling on a substantially large flat horizontal paved surface at a high rate of speed, such as for instance 100 mph, and steering wheel **120** were to be turned hard to the right (or the left), ASRLD **110** would prevent steering wheel **120** from being turned to the right (or the left) to the point that the vehicle would rollover to the left (or to the right), and would more specifically, allow steering wheel **120** to be turned to the right (or the left) very near to but just less than the threshold of vehicle rollover. Further, in the above described scenario, if the right hand (or left hand) steering load were maintained on steering wheel **120** and the vehicle was to be allowed to decelerate, such as by coasting or by braking, the vehicle would turn to the right (or to the left) at an substantially continuously sharper right hand (or left hand) turn (e.g. a substantially decreasing turn radius) corresponding to the decreased rate of speed until the vehicle slowed to the point that it would be traveling at less than the first or slowest steering prevention threshold (such as less than 10 mph). Once the vehicle slowed to the first or slowest steering prevention threshold, the vehicle would then turn to the right (or to the left) at a constant turn rate which would be the full unrestricted turn rate of the vehicle. Thus by this description, it can be seen that at substantially any speed of the vehicle, the vehicle is allowed to turn at a rate approaching but just less than the vehicle rollover threshold for such given "any" speed. ASRLD **110** is somewhat analogous to "anti-lock braking". With anti-lock braking, braking and vehicle control is maximized (breaking distance minimized) by allowing the brakes to apply a braking force that approaches but is never allowed to exceed the tire-to-ground traction breaking threshold. Analogously, with ASRLD **110**, steering and vehicle control is maximized by allowing the vehicle to be steered to a degree that approaches but is never allowed to exceed the vehicle rollover threshold.

What is claimed is:

1. An anti-roll steering apparatus having:

a steering wheel in operative communication with a set of guide wheels of an automobile such that rotation of said steering wheel causes a corresponding change in the angular position of said guide wheels relative to the body of said automobile,

at least one sensor adapted to sense the magnitude of at least one driving parameter comprising at least one of automobile speed, degree of steering turn, automobile center of gravity, automobile suspension stiffness, automobile wheelbase width, automobile loading, automobile tire pressure, traction between a road and automobile tires, and road bank angle,

at least one actuator operatively adapted to actuate upon receipt of an actuation signal, and

an electronic control unit adapted to send an actuation signal to said actuator when a sensed driving parameter exceeds a predetermined magnitude,

wherein said apparatus has a first mode that allows said automobile to be steered within a maximal non-rollover steering range of motion of said automobile but prevents said automobile from being steered beyond a rollover threshold of said automobile at any rollover capable speed of said automobile regardless of an oversteer rotational load being applied to said steering wheel and regardless of the source of said oversteer rotational load, and

wherein said apparatus has a second mode that allows said automobile to be steered within a maximal non-rollover steering range of motion of said automobile but does not prevent said automobile from being steered beyond a rollover threshold of said automobile, and

wherein said apparatus transitions from said first mode to said second mode in response to an application of a non-oversteer-rotational load to said steering wheel, and

wherein if said guide wheels are turned beyond an angular position point of a rollover threshold of said automobile, said automobile will roll over.

2. The apparatus of claim **1**, wherein said automobile comprises a non-autonomously steered automobile, and wherein said source of said oversteer rotational load comprises a human applied oversteer rotational load source.

3. The apparatus of claim **1**, wherein said apparatus is automatically actuated in response to the speed of said automobile.

4. The apparatus of claim **1**, wherein said actuation signal is sent by said electronic control unit when a combination of sensed automobile speed and degree of steering turn approach a rollover threshold of said automobile.

5. The apparatus of claim **1**, wherein said application of a non-oversteer-rotational load to said steering wheel defines an application of load to said steering wheel such that said steering wheel is rotated to a rotational orientation of below a steering prevention threshold.

6. An anti-roll steering apparatus having:

a steering device in operative communication with at least one guide wheel of a vehicle such that rotation of said a steering device causes a corresponding change in the angular position of said at least one guide wheel relative to the body of said vehicle,

at least one sensor adapted to sense the magnitude of at least one driving parameter,

at least one actuator operatively adapted to actuate upon receipt of an actuation signal, and

an electronic control unit adapted to send an actuation signal to said actuator when a sensed driving parameter exceeds a predetermined magnitude,

wherein said apparatus has a first mode that allows said vehicle to be steered within a non-rollover steering range of motion of said vehicle but prevents said vehicle from being steered beyond a rollover threshold of said vehicle at any rollover capable speed of said vehicle regardless of an oversteer load being applied to said a steering device and regardless of the source of said oversteer load, and

wherein said apparatus has a second mode that allows said vehicle to be steered within a non-rollover steering range of motion of said vehicle but does not prevent said vehicle from being steered beyond a rollover threshold of said vehicle, and

wherein said apparatus transitions from said first mode to said second mode in response to an application of a non-oversteer load to said steering device.

7. The apparatus of claim **6**, wherein said vehicle comprises a non-autonomously steered vehicle, and wherein said source of said oversteer load comprises a human applied oversteer load source.

8. The apparatus of claim **6**, wherein said apparatus is automatically actuated in response to the speed of said vehicle, and wherein if said at least one guide wheel is turned beyond an angular position point of a rollover threshold of said vehicle, said vehicle will roll over.

9. The apparatus of claim **6**, wherein said steering device defines a steering wheel.

10. The apparatus of claim **6**, wherein said at least one sensor is adapted to sense the magnitude of at least one driving parameter comprising vehicle speed, degree of steering turn, vehicle center of gravity, vehicle suspension stiffness, vehicle wheelbase width, vehicle loading, vehicle tire pressure, traction between a road and vehicle tires, and road bank angle.

11. The apparatus of claim **6**, wherein said actuation signal is sent by said electronic control unit when a combination of sensed vehicle speed and degree of steering turn approach a rollover threshold of said vehicle.

12. The apparatus of claim **6**, wherein said application of a non-oversteer load to said steering device defines an application of load to said steering device such that said steering device is adjusted to an orientation of below a steering prevention threshold.

13. The apparatus of claim **6**, wherein said input to said steering device defines an application of load to said steering device such that said steering device is adjusted to an orientation of below a steering prevention threshold.

14. An anti-roll steering apparatus having:

a steering device in operative communication with at least one guide wheel of a vehicle,

at least one sensor,

at least one actuator, and

an electronic control unit,

wherein said apparatus has a mode that allows said vehicle to be steered within a non-rollover steering range of motion of said vehicle but prevents said vehicle from being steered to a point of vehicle roll regardless of an oversteer load being applied to said steering device and regardless of the source of said oversteer load, and

wherein said apparatus transitions from said mode in response to an input to said steering device.

15. The apparatus of claim **14**, wherein said vehicle comprises a non-autonomously steered vehicle, and wherein said source of said oversteer load comprises a human applied oversteer load source, and wherein said input to said steering device comprises a non-oversteer load applied to said steering device.

16. The apparatus of claim **14**, wherein said apparatus is automatically actuated in response to the speed of said vehicle, and wherein if said vehicle is steered beyond a rollover threshold of said vehicle, said vehicle will roll over.

17. The apparatus of claim **14**, wherein said steering device defines a steering wheel.

18. The apparatus of claim **14**, wherein said at least one sensor is adapted to sense the magnitude of at least one driving parameter comprising vehicle speed, degree of steering turn, vehicle center of gravity, vehicle suspension stiffness, vehicle wheelbase width, vehicle loading, vehicle tire pressure, traction between a road and vehicle tires, and road bank angle.

19. The apparatus of claim **14**, wherein said actuation signal is sent by said electronic control unit when a combination of sensed vehicle speed and degree of steering turn approach a rollover threshold of said vehicle.

20. The apparatus of claim **14**, wherein said apparatus has a first mode and a second mode, and wherein when said apparatus is in said first mode, said apparatus allows said vehicle to be steered within a non-rollover steering range of motion of said vehicle but prevents said vehicle from being steered beyond a rollover threshold of said vehicle, wherein when said apparatus is in said second mode, said apparatus allows said vehicle to be steered within a non-rollover steering range of motion of said vehicle but does not prevent said vehicle from being steered beyond a rollover threshold of said vehicle, and wherein said apparatus automatically performs at least one of a transition from said first mode to said second mode and a transition from said second mode to said first mode.

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